# WRC-CANR-DF
# CAN-Bus Fiber Optic Bus Extender
# User's Manual

**Western Reserve Controls, Inc.**

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Document PUB 14.1
Rev 1.04
July 2000

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# 1. Overview

The WRC-CANR-DF-DN Fiber Optic CAN Bus Extender converts a copper cable medium CAN-Bus network to a fiber optic medium. The WRC-CANR-DF-DN is always used in pairs and, along with the fiber optic cable set, inserts a length of fiber media into the copper CAN Bus network. It typically is used to convert a section of the CAN bus to a pair of fiber optic cables. The primary purposes of configuration is to extend the maximum length defined for one continuous network cable bus and to provide network protection from external, high-energy electrical interference, such as lightning storms, arc welders, etc. They can be connected in a bus trunk line or drop line.

The Extenders are transparent to the other nodes on the bus. They receive and actively re-transmit (store-and-forward) each message received at either side of the network without interpreting the message or acting upon it. The Fiber Extenders perform all appropriate CAN Bus arbitration on the copper bus as it re-transmits the message.

The WRC-CANR-DF-DN is a member of WRC's family of products that extend the system communications lengths for DeviceNet, SDS (Smart Distributed System) and other CAN, V2.0, Part A, serial bus systems. By allowing the user to extend the bus length for any given speed, they assist the user in cost-effectively implementing I/O or other nodes on these buses at remote locations that would be more difficult or more expensive to do otherwise.

The unit derives its power through the copper network connector on Side A.

## *1.1. Features*

The WRC-CANR-DF-DN has the following features:

- Extends CAN-Bus cable lengths - trunk line or drop lines
- Expands the usable applications for CAN-Bus systems
- Allows operation at higher speeds for specific distances
- Provides superior electrical interference protection to copper cables
- Operates at 125K, 250K and 500K baud
- Autobaud version standard, fixed baud rate optional
- Automatic speed selection - no configuration required
- Isolates the two sections of the copper bus
- Transparent to the Master and Slave devices on the bus
- No address selection needed
- No configuration parameters
- DeviceNet; SDS; CAN, V2.0, Part A compatible
- Powered from the 24Vdc supplied by bus network or the user
- Sealed NEMA-4X enclosure
- Standard round, mini-style connector with male pins for copper cable
- Standard Fiber Optic ST female connector, 62.5/125um technology
- Standard CAN chips manage bus error detection
- Standard CAN chips handle message bus contention
- Less than 100 µsec latency
- Termination built in on cable side (may be removed by user when appropriate)
- 4 bi-color (red/green) status LEDs

- 2 green fiber transmit and receive LEDs

## 1.2. Basic Operation

Two CANR-DF units are required for each application – a CANR-DF Type 1 and a CANR-DF Type 2. These are similar devices that must be used in matching pairs. It does not matter which type is placed in which position with respect to the network topology or other devices on the network.

There are two bus connections for each CANR-DF, referred to as the Copper Cable Network Side (Side A) and Fiber Cable Network Side (Side B). The CAN Bus copper cable is connected to side A of the CANR-DF receives its power from side A.

**Error! Reference source not found.** for a typical application.

Whenever a message is transmitted on the Bus to which CANR-DF is connected, CANR-DF receives the message on the side where it was initiated and performs a store-and-forward of the message to the other side. This action is performed in each direction and is performed for any valid CAN message independent of who generated it or to whom it is intended.

There is approximately a 75µsec propagation delay of the message through the CANR-DF.

The CANR-DF is not addressed as a specific device on the Bus and cannot be interrogated by other nodes. It is transparent to all other nodes on the bus.

## 1.3. Reference Documents

The following documents are referenced in this User's Manual

- ODVA DeviceNet Specification Volume I, Release 2.0
- Honeywell Micro Switch Specification GS 052 104, "SDS Smart Distributed System Physical Layer Specification", release date 12/8/1994

# 2. Quick Start

To quickly and easily install your CAN-Bus Fiber Optic Extenders in your DeviceNet system, follow the instructions below. For more details, see Section 4.

1. These units are used in pairs. You need a **CANR-DF Type 1**, a **CANR-DF Type 2** and **two (2) fiber cable lengths**, terminated with ST male connectors.
2. Set the baudrate of each CANR-DF using switches 5 and 6 on the 6-position switch block SW1.

Table 2-1

| Baudrate | Switch 5 | Switch 6 |
|---|---|---|
| 125k | ON | ON |
| 250K | ON | OFF |
| 500K | OFF | ON |

3. Make sure that there is power on the copper CAN-Bus Network A and plug the Network A cable into the CAN-Bus Extender on the side marked Network A.
4. The CANR-DF Extender will undergo its initialization sequence, flashing the LEDs. After approximately 5 seconds, the Module Status LED (labeled "MS") will go on solid green and network LEDs (labeled "NSA" and "NSB") will flash green.
5. Connect the fiber cables to the Fiber Network Side B.
6. Connect the second CANR-DF as above. Be sure to connect the fiber from the TX port on one device to the RX port on the other.
7. Both Network A and B Status LEDs (NSA and NSB) will go on solid on each unit once a valid CAN message is received into either side of the Extender and the baudrate auto-detect has been successfully performed (if applicable).
8. You may observe the small green LEDs marked RXF and TXF, next to the fiber ports, flicker when data is received or transmitted.
9. The CAN-Bus Extenders are now operating on the network and they are ready operate in the CAN network.
10. If the red LED marked DGN (diagnostic) blinks, this indicates that the internal message buffer on the CANR-DF has been filled before the device could transfer all previously received messages out the other side. Some messages may be lost. Slowing down the scan rate should help eliminate this.

# 3. General Specifications

**Product**: WRC-CANR-DF-DN CAN-Bus Extender and Fiber Optic Converter

**Description**: Electrical Extender to extend the cable distances of CAN-based protocol products and convert the copper network to a fiber optic link.

**Device Type**: Communications Extender

**Product Revision**: 2.05

**DeviceNet Conformance**: Designed to conform to the ODVA DeviceNet Specification Volume I, Version 2.0 and Volume II, Version 2.0.

**Baud rate**: 125K, 250K, 500K fixed baud rate

**Address selection**: Not applicable

**Bus Connection**:
Used On Device: Turck # RSF50, male pins, male threads
CAN-Bus Cable: See accessories list

**Fiber Connection**:
Used On Device: ST female
Fiber Cable: ST male

**Status Indicators**:
MS - Module Status: green/red bi-color LED
NSA - Copper Network A Status: green/red bi-color LED
NSB - Fiber Network B Status: green/red bi-color LED
DGN - Diagnostic Data: green/red bi-color LED
TXF - Fiber Transmit Active: green LED
RXF - Fiber Receive Active: green LED

**Voltage Isolation**: Provided by fiber cable system

**Maximum power**:
Voltage: 11 - 25 Vdc
Current: 160 mA @ 11 Vdc - 70 mA @ 25 Vdc
Power: 1.8 W

**Mounting**: Panel-mount, 4 screws

**Size**:
Length: 5.11" (130 mm)
Depth: 2.27" (57,7 mm)
Height: 3.70" (94,0 mm)

**Operating Temp**: 0-70 ºC

**Humidity**: 0-95% RH, non-condensing

# 4. Hardware Installation and Configuration

## *4.1. Overview*

A CAN-Bus Extender is a single device connected to two parts of a single CAN-Bus network. The CANR-DF is a NEMA-4X enclosure and is panel mounted.

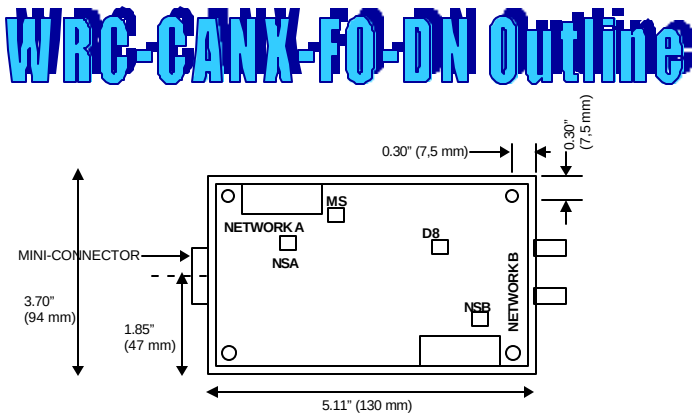


Figure 4-1 WRC-CANR-DF-DN CAN-Bus Extender

## *4.2. LED Operation*

A WRC-CANR-DF-DN Multiplexer has six (6) LEDs that provide visual status information to the user about the product and the DeviceNet network. See Figure 4-1, Table 4-1, Table 4-2 and Table 4-3.

Table 4-1 Module Status LED (labeled MS)

| LED State | Module Status | Meaning |
|---|---|---|
| OFF | No Power | There is no power through DeviceNet. |
| Green | Device Operational | WRC-CANR-DF-DN is operating normally. |
| Flashing Green | Device in Standby | WRC-CANR-DF-DN is in intialization. |
| Flashing Red | Minor Fault | Recoverable fault. |
| Red | Unrecoverable Fault | WRC-CANR-DF-DN may be damaged. |
| Flashing Red/Green | Device Self-Testing | WRC-CANR-DF-DN is in self-test mode. |

Table 4-2 Network Status LEDs (labeled NSA and NSB)

| LED State | Module Status | Meaning |
|---|---|---|
| OFF | No Power / Not on-line | WRC-CANR-DF-DN has no power or device is not operating. |
| Flashing Green | Autobaud selection | The WRC-CANR-DF-DN is waiting for a valid message to fix the baudrate. |
| Green | On-line | WRC-CANR-DF-DN is operating normally. |
| Flashing Red | Communications error | One of several communications errors (defined below) has occurred. |
| Red | Critical link failure | WRC-CANR-DF-DN has detected an error which makes it incapable of communicating on the link. |

Communications errors include:

- Transmit Check
- Bus Off
- Error Passive
- Warning Level

Table 4-3 Diagnostic Status LEDs (labeled DNG)

| LED State | Module Status | Meaning |
|---|---|---|
| OFF | No Power / Not on-line | Normal operation. |
| Flashing Green | Autobaud selection | Waiting for a valid message to select the baud rate. |
| Green | On-line | Not defined. |
| Flashing Red | Communications error | The internal FIFO stack has overflowed on one of the network sides because the other network could not complete communications. |

Green LED TXF is illuminated when data is actively transmitted out to the fiber link.

Green LED RXF is on solid when its fiber cable is connected to the TX port of an active CANR-DF. This LED flashes when data is actively received from the fiber link.

## 4.3. DIP Switch Settings

The WRC-CANX-XX Multiplexer has a 6-pole DIP switch. Switch positions 5 and 6 are used to set the baud rate. (Switch positions 1-4 are reserved for future functions.)

Table 4-4 Baud Rate Settings

| Baud rate | Position 1-4 | Position 5 | Position 6 |
|---|---|---|---|
| 125K | n/a | ON | ON |
| 250K | n/a | ON | OFF |
| 500K | n/a | OFF | ON |
| Autobaud | n/a | OFF | OFF |

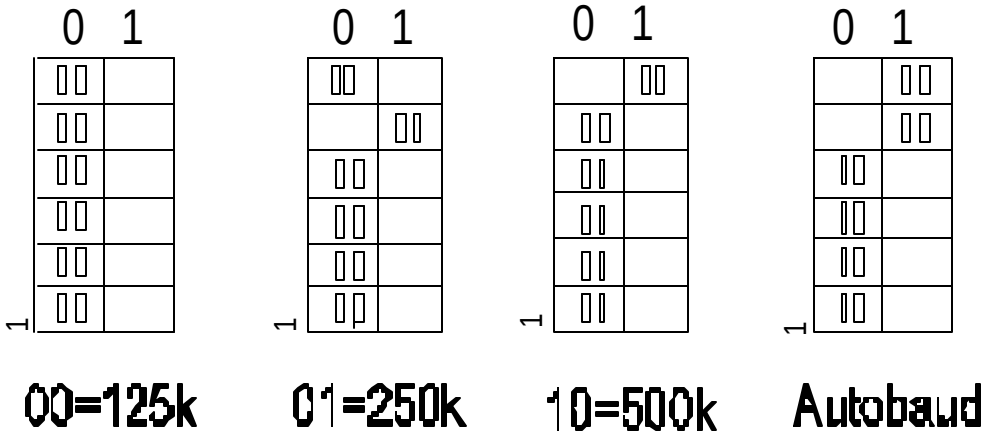


Figure 4-2 DIP Switch Setting for Baud Rate

## 4.4. Power Requirements

The WRC-CANR-DF-DN CAN-Bus Extender subsystem is powered from the 11-25 Vdc provided by the DeviceNet network. The WRC-CANR-DF-DN consumes 70 mA of current at 24 Vdc, or 1.8 Watts, typical. See Section 3.

## 4.5. Network Cabling and Configuration

This section provides general guidelines for connecting DeviceNet and SDS systems. You can find detailed specifications in the referenced ODVA DeviceNet and Honeywell SDS specifications.

### 4.5.1. Cable Lengths

The following provide cable length limits for DeviceNet and SDS systems. These numbers apply independently to each physical section of the network, whether it is copper or fiber.

Table 4-5 Network Maximum Lengths - DeviceNet

| Baud Rate | Trunk Line Length | | Drop Length | | | |
|---|---|---|---|---|---|---|
| | Maximum Distance | | Maximum | | Cumulative | |
| | Meters | Feet | Meters | Feet | Meters | Feet |
| 125 Kbits/s | 500 m | 1640 ft | 6 m | 20 ft | 156 m | 512 ft. |
| 250 Kbits/s | 250 m | 820 ft | 6 m | 20 ft | 78 m | 256 ft. |
| 500 Kbits/s | 100 m | 328 ft | 6 m | 20 ft | 39 m | 128 ft. |

DeviceNet has a limit of 64 nodes per network for any baud rate. The CANR-DF is transparent to the network and does not count as an addressed device. However,

Table 4-6 Network Maximum Lengths - SDS

| Baud Rate | Trunk Line Length (maximum) | | Drop Length (maximum) | | No. of Nodes |
|---|---|---|---|---|---|
| | Meters | Feet | Meters | Feet | |
| 125 Kbits/s | 457.2 | 1500 | 3.6 | 12 | 64 |
| 250 Kbits/s | 182.8 | 600 | 1.8 | 6 | 64 |
| 500 Kbits/s | 91.4 | 300 | 0.9 | 3 | 64 |
| 1 Mbits/s | 22.8 | 75 | 0.3 | 1 | 32 |

SDS has a limit of 32 nodes per network for any baud rate. The CANR-DF does not count as an addressed device.

### 4.5.2. Network Termination

A CAN-Bus system **must be terminated at each end of a copper trunk line**. The host controller and the **last** node device or WRC CAN-Bus Extender on the network must always be terminated to match impedance and eliminate reflections, even if only two nodes are present. Follow the information below when using a CANR-DF.

**Trunk line use:**

For the purpose of network termination, the CANR-DF is treated as the last node on the copper section of the trunk network (side A) to which it is connected. Therefore, when a CANR-DF is used directly in a trunk line, it must be terminated on side A. A terminating resistor is built into the CANR-DF, so that an external resistor should not be added.

**Drop line use:**

When CANR-DF is used in a drop line line (the Network A side is toward the main trunk), the Network A connection is **not terminated**. The user must remove the built-in terminator by clipping it out of the circuit.

Some specifications for the terminating resistor are:

Table 4-7 Terminating Resistors

| DeviceNet | SDS |
|---|---|
| 121 ohm<br>1% metal film<br>1/4 watt | 120 ohm<br>2%<br>1/4 watt |

**Important**: Per the DeviceNet and SDS specs -- do not terminate devices on drop lines.

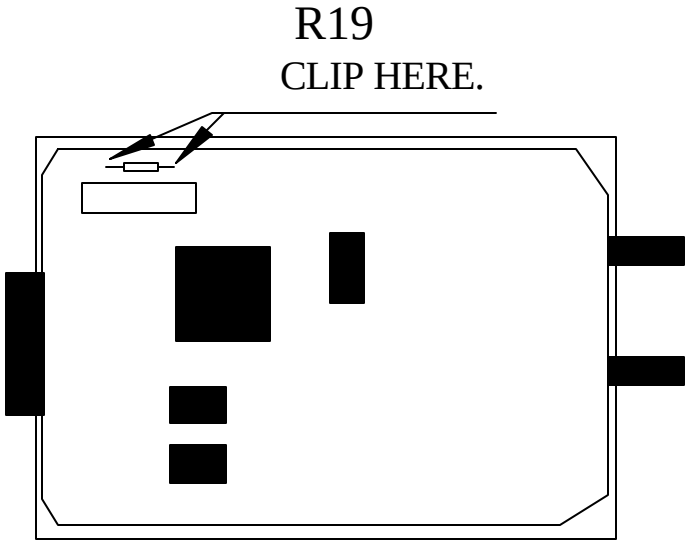


Figure 4-3 Location of Terminating Resistor on Network Side A

### 4.5.3. CAN-Bus Connection Wiring

The CANR-DF uses the round, mini-style connector on the copper side A and standard ST connectors on the fiber side B.

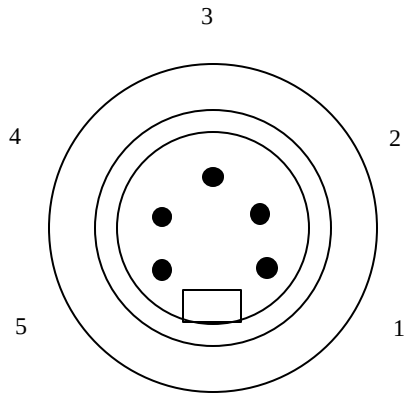


Figure 4-4 DeviceNet Network Side A cable connector – Male (pins)

| Pin # | Function | Wire color |
|---|---|---|
| 1 | drain | bare |
| 2 | V+ | red |
| 3 | V- | black |
| 4 | CAN_H | white |
| 5 | CAN_L | blue |

Table 4-8 DeviceNet cable specifications

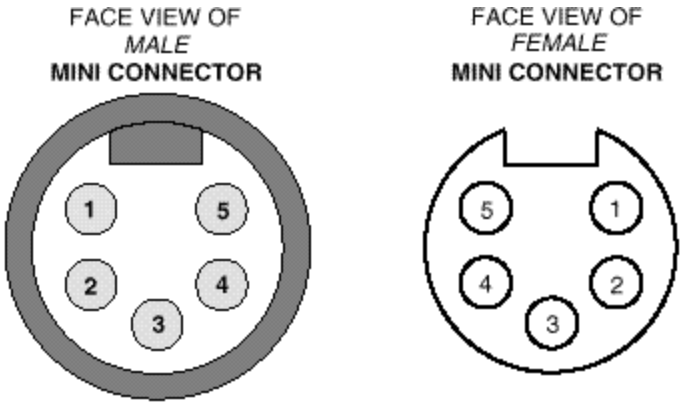


Figure 4-5 SDS Mini Connector

| Pin # | Function | Wire color |
|---|---|---|
| 1 | drain | Bare |
| 2 | V+ | Brown |
| 3 | GND | Blue |
| 4 | CAN_H | Black |
| 5 | CAN_L | White |

Table 4-9 SDS cable specifications

### 4.5.4. Alternate Connector Options

Cable sets may be purchased from an appropriate vendor or custom-made. Turck supplies individual connectors that may be used to build custom DeviceNet or SDS copper cables. Turck part number B 4151-0/16 is a 5-pin, 600V, 9A connector that mates with a number of cables that may be used for the Network A side on the CANR. Contact WRC or your local Turck dealer.

# 5. Operation

CANR-DF receives and stores messages received at either network connection and actively re-transmits the message while providing 2500V isolation between the two sections of the nework. The two bus connections for each CANR-DF are referred to as Network A (copper wire), and Network B (fiber optic cable), but they are the same logical network with isolation between them. To extend the maximum distance that a network.

This inclusion of the fiber network section into your CAN-Bus system requires that the the CANR-DF units be used in pairs. And each pair consist of one Type 1 CANR-DF and one Type 2.

The CAN Bus is connected to the A Side of the CANR-DF and receives its power from the Bus.

Whenever a message is transmitted on the Bus to which the CANR-DF pair is connected, one CANR-DF receives the message on the side where it was initiated and performs a store-and-forward of the message to the other side. This action is performed for any valid CAN message independent of who generated it or to whom it is intended.

There is approximately a 75 µsec propagation delay of the message through the CANR-DF.

The CANR-DF is not addressed as a specific device on the Bus and cannot be interrogated by other nodes. It is transparent to all other nodes on the bus.

## *5.1. Application Notes*

**NOTE: CANR-DF'S ARE ALWAYS USED IN PAIRS!**

To help insure ease of installation and reliable operation of your system, the following guidelines should be followed CANR-DF installation in your CAN network.

1. Make sure the pair consists of a Type 1 and a Type 2.
2. For Autobaud versions, the baud rate each device selects will be defined by the first valid message received from either the CAN-Bus or via the fiber connection from the other device.
3. Use only one CANR-DF pair in any network section. That is, only use one CANR-DF pair per trunk line or drop line.
4. CANR-DF is not a grounded device and the Bus shield is not connected electrically to the device. Therefore, follow appropriate wiring practices to eliminate noise and other problems.

Examples of valid configurations are shown in the following figures.

Figure 5-1 CANR-DF on a drop line

Figure 5-2 CANR-DF on Trunk Line and Drop

# 6. Accessories and Other WRC Products

The following components can be used with a JDxx for replacements or spare parts, or as complementary devices as a part of your DeviceNet system.

Table 6-1 Accessories and Other WRC Products

| Part | WRC Part Number |
|---|---|
| DIN rail | WRC 50022 |
| Terminating resistor, axial lead | RM121DN |
| Connector, 5-pin mini-round for CANX, CANR | B 4151-0/1 (Turck) |
| Discrete I/O block – 4 channels | 1782-JDB4 |
| Discrete I/O block – 8 channels | 1781-JDB8 |
| Analog Input block – 4 channels, 10-bit | 1782-JDA4 |
| Analog I/O block – 8 channels, 12-bit | 1782-JDA8 |
| DeviceNet to Serial I/O Gateway | 1782-JDC |
| DeviceNet to Modbus Gateway | 1782-JDM |
| Discrete I/O block – 24 channels | WRC1-JDB24 |
| Discrete I/O block – 48 channels | WRC1-JDB48 |
| Discrete I/O, Analog Input block – 24 DIO, 32 AI | WRC1-JDA/24 |
| Discrete I/O, Analog Input block – 48 DIO, 32 AI | WRC1-JDA/48 |
| Analog I/O block - 32 channels | WRC1-JDAIO |
| Discrete and Analog I/O block – 24 DIO, 32 AIO | WRC1-JDAIO/24 |
| Discrete and Analog I/O block – 48IO, 32 AIO | WRC1-JDAIO/48 |
| Discrete I/O block – 8 DIs, 8 DOs, 4 AIs | W5-JDB16x |
| DeviceNet, CANopen Extender, DIN mount | WRC-CANX-DIN-DN |
| SDS Extender, DIN mount | WRC-CANX-DIN-SD |
| DeviceNet, CANopen Extender, DIN mount | WRC-CANX-DIN-C7 |
| DeviceNet, CANopen Extender, NEMA box | WRC-CANX-NEM-AU |
| DeviceNet, CANopen Extender, NEMA box | WRC-CANX-NEM-DN |
| SDS Extender, NEMA box | WRC-CANX-NEM-SD |
| DeviceNet, CANopen Extender, Fiber Optic, NEMA box | WRC-CANR-DF-DN |

# 7. Troubleshooting

This section identifies some of the common problem observed when commissioning or operating a CANR-DF Extender.

Problem:

Device will not communicate on the network
Module Status LED is solid Green
Network Status LED is flashing Green

Possible Solutions:

1. CANR does not see CAN messages on the network.
2. Network does not have a terminating resistor. Add a 121 ohm resistor across the CAN_H and CAN_L signals at the first and last nodes.
3. Network cable is broken or disconnected.
4. Network cable is miswired.

Problem:

Device will not communicate on the network
RX LED is not on solid.

Possible Solutions:

1. Network cable is broken or disconnected.

Problem:

Device does not communicate every message on the network
DGN LED flashes Red.

Possible Solutions:

1. CANR internal message buffer is filled. Some messages are not accepted. Reduce the amount of traffice on the network.
2. Increase the scan time period.